SA-O17 AAPPS-DPP2020

4th Asia-Pacific Conference on Plasma Physics, 26-31Oct, 2020, Remote e-conference

Classification of Filament Formation Mechanisms in Magnetized Molecular Clouds

Daisei Abe[1], Tsuyoshi Inoue[1], Shu-ichiro Inutsuka[1]
[1] Department of physics, Graduate School of Science, Nagoya University
e-mail (speaker): d.abe@nagoya-u.jp
As an AAPPS-DPP standard, we do not need to add your postal address.

The star formation process is the foundation of the physical processes like galaxy evolution and planet formation, thus it is important to reveal the detail of it. Stars are formed in dense regions in molecular clouds (e.g., Lada et al. 2010). Recent observations of nearby molecular clouds show that filamentary structures whose mass per unit length exceeds the critical value for gravitational instability are the sites of star formation (e.g., André et al. 2010). Therefore, it is important to comprehend the filament formation process, since the filaments give the initial condition for star formation.

It has been proposed by many theoretical studies that shock waves in molecular clouds trigger filament formation. In general, shock waves are frequently induced in molecular clouds, e.g., by supernovae and radiative stellar feedbacks. However, several mechanisms are proposed as filament formation mechanism triggered by the shock, indicating that it is necessary to identify the formation mechanism of observed star-forming filaments.

In this study, we perform a series of isothermal magnetohydrodynamics simulations of the filament formation (see Figure 1) by using the SFUMATO code (Matsumoto 2007). We investigate the influences of shock Mach number and turbulence on the filament formation process. We find that when the shock wave is strong (Sonic and Alfvénic Mach numbers are respectively $\mathcal{M}_s$=35 and $\mathcal{M}_A$=5), the gas flows driven by the oblique shock create filaments regardless of the turbulence and self-gravity (e.g., Inoue & Fukui 2013). When the shock wave is weak ($\mathcal{M}_s$=12.6 and $\mathcal{M}_A$=1.8), turbulence naturally contained in molecular clouds induces the filament formation (e.g., Chen & Ostriker 2014, Padoan & Nordlund 1999). When both the Mach numbers and turbulence are low, filaments are formed as a result of the self-gravitational fragmentation in the shock compressed sheet (e.g., Nagai et al. 1998). Also, we calculate the line-mass distribution of the simulated filaments. The results show that the strong shock wave is necessary to form the massive filaments like those observed in the massive star-forming regions (e.g., Fukui et al. 2019). We conclude that the dominant filament formation mechanism changes with the Mach numbers of the shock wave and the turbulence.

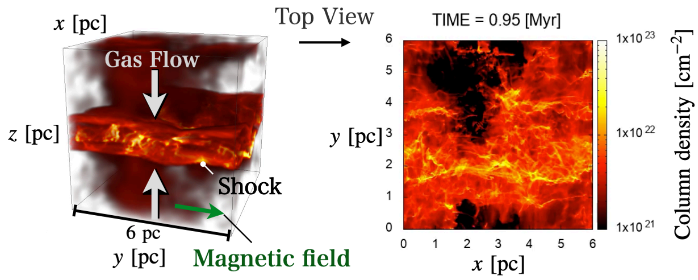

Figure 1. One of result in our simulations. *Left*: three -dimensional schematic. Yellow represents a dense region. *Right*: Top view of the left schematic. "TIME" means elapsed time since collision is started.

References

André, P., Men'shchikov, A., Bontemps, S., et al. 2010, doi: 10.1051/0004-6361/201014666

Chen, C. Y., & Ostriker, E. C. 2014, Astrophys. J., 785, doi: 10.1088/0004-637X/785/1/69

Fukui, Y., Tokuda, K., Saigo, K., et al. 2019, ApJ, 886, 14, doi: 10.3847/1538-4357/ab4900

Inoue, T., & Fukui, Y. 2013, Astrophys. J. Lett., 774, doi: 10.1088/2041-8205/774/2/L31

Lada, C. J., Lombardi, M., & Alves, J. F. 2010, ApJ, 724, 687, doi: 10.1088/0004-637X/724/1/687

Matsumoto, T. 2007, Publ. Astron. Soc. Japan, 59, 905, doi: 10.1093/pasj/59.5.905

Nagai, T., Inutsuka, S., & Miyama, S. M. 1998, Astrophys. J., 506, 306, doi: 10.1086/306249

Padoan, P., & Nordlund, A. 1999, Astrophys. J., 526, 279, doi: 10.1086/307956

Note: Abstract should be in 1 page.